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Preface

This memo is written as an input to the German project Enef-haus on energy-efficient restoration of single-family houses in Germany. The memo contains a summary of the Danish experiences divided into three main sections: first is a short historic overview of the Danish energy policy indicating when different relevant instruments have been introduced to increase the energy efficiency of privately owned single-family houses. Second is a short introduction to the Danish housing sector and its energy supplies. The third and main part of the report is an examination of the most recent and relevant instruments concluding both on the results concerning the impact of the instruments especially on owners of single-family houses and on more general experiences with their implementation. Finally the memo concludes on the general lessons that can be learned from the Danish experiences.

Danish Building Research Institute, Aalborg University
Department of Town, housing and property
December 2010

Hans Thor Andersen
Research director

Historic overview of instruments used in Denmark

There is a long tradition for energy saving and energy efficiency policy in Denmark, and the detached houses have been central in several of the initiatives as households have stood for between a quarter and a third of the total Danish energy consumption throughout the last thirty years. The Danish energy policy has been quite stable since the early 1970s with a focus on economy, security of supply and environment, though the balance between these three objectives have changed over the years towards still more focus on the environment since the 1990s.

Following the energy crisis in 1973 the first complete Danish energy plan was published in 1976. Focus was on energy security obtained through change of energy sources (becoming less dependent on oil without introducing nuclear power) and through energy savings. In 1977 energy taxes were introduced and in 1979 a tightening of the building regulations was for the first time used to reduce energy consumption in new buildings. In 1980 subsidies for energy renovations was introduced. These three elements (taxies, subsidies and building regulation) was used during the 1980s and 1990s, combined with different kinds of public campaigns and other types of information, to effect the homeowners to make energy renovations.

The governmental energy plan from 1990 had the goal of reducing energy consumption with 15% and CO_2 emissions with 20% before 2005. In the 1990s tax and subsidies for the trades and industries were introduced, norms for appliances' energy consumption were introduced, the first Danish energy labels on buildings was introduced in 1997, and the Danish Electricity Saving Trust was established the same year with an annual budget of 90 million DKK (12 million Euro) and the aim of promoting conversion from electricity heating to other energy sources and to promote energy efficient appliances. Also in the 1990s the (private) utilities and grid companies started to advise on energy savings and since 2006 this has been a legal obligation according to the law of Public Service Obligations (PSO) with a budget of approximately 300 million DKK (40 million Euro) a year, financed by a tax on consumed electricity. Public money has also been given to grass-roots organisations for advising consumers and others on energy savings and to create an alternative to the initiatives from the private energy companies. From 2004 to 2008, 25 mio DKK per year (3,3 mio Euro) was distributed by the energy saving pool for these initiatives.

The latest energy agreement in Denmark is from 2008 and it follows the lines from previous energy policy by focusing on the increase of renewable energy production and setting goals for $C0_2$ reductions and energy efficiency. However, energy policy is to a still higher degree a European affair. The influence from EU is also seen in the fact that the Danish scheme on energy labelling of buildings in 2006 was replaced by the European European Energy Performance of Buildings Directive (EPBD). In the 2008 agreement the means concerning energy savings in buildings are a continued tightening of the building regulations, continued obligations for the energy companies to obtain energy savings, funds for campaigns and Knowledge Centre for energy savings in buildings.

Throughout all the years, public money for research and development has also been part of the energy policy. In this way, policy goals, technology development and energy efficiency means have been developed together. For instance, the building regulations have followed the latest advancements within technology development.

As it can be seen, the Danish energy policy regarding private house owners has been a mixture of legal, economic and informational means. In recent years, the responsibility for executing several of the activities have been transferred from the authorities to other semi-public or private companies, and the Danish energy policy thus follows the lines of what have been called new public management or "from government to governance"[1]. The idea is to a higher degree to use the power structures in society to work for the policy goals rather than just using top-down governmental regulation. The Electricity Saving Trust, the Utilities' saving obligations and the idea of energy labels are all different examples of the use of public-private-partnership (PPP) and market mechanisms to work for energy savings.

[1] For a description of this type of policy in relation to the Danish Building sector see (Jensen and Gram-Hanssen 2008)

Introduction to the Danish housing sector and its energy supplies

When discussing the international learning from the Danish experiences with energy efficiency means aimed at owners of single-family houses, it may be relevant to establish a few facts about the Danish housing sector and its energy supply.

The Danish housing stock consists of approximately 40% apartments, 46% single-family houses and 14% terraced houses. A third of all housing in Denmark was built in the 1960s and 1970s, and more than 80% of all housing was built before 1980 (Statistisk årbog 2004), i.e. *before* the energy requirements were introduced in the Danish building regulations.

The Danish households are primarily heated by district heating (61%). Natural gas burners are used in 15% of the households and oil-fired burners in another 15%, whereas the rest (app. 9%) uses electricity, wood burning stove and others. Most of the district heating is produced by combined power-heat production. More than 40% of the district heating is based on renewable energy, more than 20% on natural gas and the rest on oil and coal. The energy efficiency of the Danish households' heat consumption has risen during the last thirty years, and energy consumption per heated square meter has been reduced by 30%. In the same period, the amount of heated square meters for housing have, however, risen equally, resulting in a more or less stable amount of energy for heating the housing sector (Energistatistikken, 2008). The rising amount of heated square meters are primarily related to a declining households size, as more and more people live alone and thus use more heated space per person (Gram-Hanssen et al. 2009).

Research have documented that 30-35% of the energy used for heating in Danish buildings could be saved by making renovations with a reasonable payback time (Witchen 2009). Other research has focused on why this is not happening and have pointed out that households not primarily acts out of economic rationality, meaning that many other aspects than payback time have to be included when understanding when and how people renovate their house (Gram-Hanssen et al. 2007).

Examination of most relevant instruments

This section introduces and evaluates the most important means in Danish energy policy aimed at energy renovations in single-family houses. It includes reviews of the building regulation, energy labels and energy inspection schemes, energy taxes, utilities saving obligations, the Electricity Saving Trust and, finally, other informational and economic incentives.

Buildings regulations

The Danish building regulations was first introduced in 1961 and included minimum requirements for the qualities of buildings in relation to fire hazard and to strength. In 1979, the building regulations for the first time also included minimum requirements for energy consumption. The building regulations have since then been tightened several times on energy requirements following new technical improvements and possibilities. From the beginning, the energy requirement was based on energy performance on the single building component, the U-value of the windows, walls etc., and the requirements furthermore only applied for new buildings. The energy requirements have changed over the years from regulation on performance of building elements to regulation on the total buildings energy performance, including energy production in the house. Furthermore, the regulations have since 2006 also included regulation on renovation and rebuilding of existing buildings.

Related to renovation/rebuilding of existing housing, the regulation distinguish between if the activities include more or less than 25% of the buildings physical surface or economic value. If the renovation includes more than 25% of the building, all renovations stated in the energy labels on the house, which are economically profitable[2], has to be implemented. Furthermore the U-values, as stated in the regulation for different types of building components, have to be kept, as well as do standards for heating supply etc. If the rebuilding includes less than 25% of the existing building, either counted as physical surface or economic value, only the U-values as stated in the regulation for different types of building component have to be kept, as well as the standards for heating supply etc[3]. The building regulations from 2006 are standardised according to EU-regulation, and thus by and large follow the regulation in other member states.

Evaluating the impact of the building regulations there is no doubt that the building year and the heating consumption correlates and new buildings have a considerable lower consumption than buildings built half a century ago. There are, however, not complete consensus on how strong this correlation is and when the most substantial effect have occurred. An article based on detached houses heated by natural gas suggests that the reduction in heat consumption between houses built in 1978 and in 1979 is stronger than for houses built the previous years, and that this is due to the building regulations energy requirements (Leth-Petersen, 2002; Togeby et

[2] Economically profitable is defined as the saving multiplied by the lifetime divided by the investment should be more than 1.33.

[3] The Danish Building regulations in English can be found at http://www.ebst.dk/br08.dk/bygningsreglementet_paa_englesk

al. 2008). Other studies based on district heated detached housing suggest that the reductions in detached houses energy consumption for space heating are quite continues from the 1940s to the 1990s, and furthermore these studies suggest that there are no reduction when comparing buildings built in the 1980s and the 1990s (Petersen and Gram-Hanssen, 2005). This indicates that the building regulations have not had that strong impact on the heat consumption of detached buildings. Both studies compare consumption in recent time for all building regardless of building year, and one obviously source of error as regard evaluating the impact of the building regulations is the fact that many of the older buildings may have been energy renovated since they were build. However, a possible problem associated with this type of regulation is that it is based on calculated or theoretical energy performances. Before starting to build, the owner has to document the energy performance of the building by using a standardised tool. Evaluations of new-built houses have suggested that even if a building, before it was build, could document low energy consumption, the actual consumption turned out to be 10% higher than the calculated after it was put into use, (Det Økologiske råd, 2002). These attempts to evaluate the Danish buildings regulations effect on energy efficient buildings, however, relates to new building. Evaluating on the part of the building regulations that relates to renovating/rebuilding is still too soon, as the regulations have only been in force for a few years.

Energy label and energy inspection schemes

There has been a long tradition in Denmark for energy inspection schemes for single-family houses in relation to heating. In June 1981 the Danish Parliament passed an act on reduction of energy consumption in buildings.[4] Besides a subsidy scheme for investments in energy savings in buildings, the act also prescribed the establishment of the so-called “Heating audit scheme”.[5] In this scheme, which was the first energy inspection scheme for single-family houses, house owners could get an authorized energy consultant to make an overall inspection and assessment of the energy standard of the house. The Heating audit was in the first years voluntary. However, a revision of the law made it in 1985 compulsory that a Heating audit should be carried out whenever a house built before 1 February 1979, i.e. before the first tightening of the energy requirements in the building regulations, was sold. The seller was issued an “Energy certificate” that contained recommendations for possible energy improvements and their related costs. The seller should show the certificate to the buyer (Boligministeriet 1998).

The Heating audit scheme was never effectively sanctioned by the authorities. As a result, fewer and fewer Heating audits were carried out. About 55% of the houses that changed owners in 1985 had an Energy certificate, but the share had fallen to about 30% in the mid-1990s (Boligministeriet 1998). This could be part of the explanation why the Heating audit scheme seemed to only have a limited energy saving impact.

An evaluation of the existing Danish schemes for energy savings in buildings, including the Heating audit scheme, was published in 1994 (Christensen et al. 1994; Togeby et al. 1994). The evaluation concluded that the existing regulation was too complicated and the energy saving effects questionable. As a result of the evaluation, the Danish Energy Agency appointed two committees to prepare proposals for a thorough revision of the Danish building energy saving schemes (one committee for small buildings and one for

[4] The act was named (in Danish): “Lov om begrænsning af energiforbrug i bygninger”. In short: “Varmesynsloven”

[5] In Danish: “Varmesynsordningen”

large buildings). The work of the committees, and the following political discussions, ended up with a new act for the promotion of energy and water savings in buildings.[6] The Danish Parliament passed the act in 1996 and by 1 January 1997 the existing schemes were replaced by two new schemes: A scheme for small buildings (floor space less than 1500 m^2) and a scheme for large buildings (floor space larger than 1500 m^2).

The three most important differences between the former Heating audit scheme and the new scheme for small buildings was: 1) The energy audit now included an energy label, which indicated the level of energy efficiency of the house compared with other similar buildings. The introduction of an energy label was regarded as a major improvement, and the scheme was actually named "The Energy Labelling scheme for small buildings".[7] The calculated energy consumption of the house was placed on a scale from A1 to C5 with A1 being the most energy efficient and C5 the least efficient. A1 would typically be given to new built low-energy houses, while single-family houses from the 1970s typically would get a grade in the lowest end of the A scale or in the top of the B scale (Kjærbye 2008). The main idea behind introducing an energy label was to make the significance of energy consumption more visible to buyers and new owners in order to motivate them to carry out the energy improvements recommended in the energy audit report. 2) The Energy audit was now compulsory for all existing buildings put up for sale as well as new buildings (and not only buildings built before 1 February 1979). Subject to the scheme was buildings used for residence, by public institutions or for private service and trade (except for buildings used for production and buildings with very low energy consumption). 3) Finally, the scope of the audit was broadened in order to include not only energy consumption for space heating and hot water, but also electricity consumption and water usage.

The real estate salesmen were obliged to inform the seller about the mandatory energy labelling scheme whenever a house was put up for sale, and the buyer had the right to request the label on the account of the seller, if it was not presented. However, the real estate salesmen turned out to be "uncommitted ambassadors" of the Energy labelling scheme, and often they did not inform sellers or buyers about the scheme and about the buyers' legal right to get an energy label. This, in combination with the lack of sanctioning by the authorities in cases of missing energy labels, resulted in a relatively low coverage. It was estimated that only 50-60% of the potential buildings had been energy labelled. (Madsen et al. 2001)

An evaluation of the Energy labelling scheme for small buildings was carried out in 2000 (Madsen et al. 2001). The main conclusions of the evaluation were (see also Laustsen & Lorenzen 2003):

- Problems with the registration and reliability of the registered data.
- Only 50-60% of the buildings subject to an energy audit had been labelled. This figure covered great geographical variations.
- No significant difference with regard to energy and water saving activities between house/flat owners with energy label versus those without. However, the evaluation notes that the recommendations included in the energy plan might have had an effect on the house owners' investment priorities.
- The scheme had a bad reputation among real estate agents, who did not trust the reliability of the scheme. The authors suggest that this distrust of the scheme might be the most important explanation of the scheme's im-

[6] In Danish: “Lov om fremme af energi- og vandbesparelse i bygninger” (LF 238 95/96)
[7] In Danish: "Energimærkningsordningen for små bygninger"

perfect coverage. It might be a fundamental problem of the scheme that it was the person selling the house who had to order (and pay for) the energy audit without obtaining direct benefit him/herself from the audit.

The limited effect of the Energy labelling scheme has been confirmed by a later quantitative study, which compared the development in actual energy consumption for heating between energy labelled and non-labelled single-family houses sold in 1999-2002 (Kjærbye 2008). Based on a statistical analysis of the actual consumption, register data on the houses and data from the energy labelling database, the study found no significant energy savings due to the Energy labelling scheme for small buildings.

While the above mentioned evaluations came to rather disappointing conclusions regarding the impact of the labelling scheme, one of the positive "side-effects" was that the scheme provided a large source of information on the building stock in Denmark (Laustsen & Lorenzen 2003).

The implementation of the EU Directive 2002/91 on Energy Performance of Buildings (EPBD) was ensured by Act no. 585 on Energy Savings in Buildings passed in the Danish Parliament in June 2005. The implementation of EPBD resulted in a number of adjustments to the existing Energy labelling scheme from 1997. These adjustments became effective from 1 January 2006. The most important changes were: 1) The labelling of electricity and water consumption was taken out of the scheme. 2) The former scale (A1-C5) was replaced by a new scale going from A1 to G2. In 2008, the subdividing of the categories B-G was skipped in order to simplify the scale. Thus, the scale now includes only the following categories: A1, A2, B, C, D, E, F, G. New buildings that meet the energy requirements of the Danish Building Regulation must at least be labelled as class B. Class A1 and A2 are for low energy buildings class 1 and 2. 3) With the revised scheme, also buildings that are rented out have to get an energy label.

The daily operation of the labelling scheme is delegated to a secretariat ("FEM-sekretariatet"), which also operates the other schemes related to the EPBD. The specific instructions and rules for carrying out the energy audit and calculating the label are described in the Handbook for Energy Consultants ("Håndbog for energikonsulenter"). The handbook, which is only in Danish, is available to the public on the website of FEM-sekretariatet, www.femsek.dk.

The Energy label report (1997-2005)	The Energy label report (2006-)
– *The energy label:* Standardised rating of the building containing information about the state of respectively heat, electricity and water installations and subsequent CO_2 emission impact. The calculated consumption of water, electricity and energy for heating is placed on a scale from A1 to C5. Includes also information on the expected total energy and water consumption in the building in a reference year and energy costs. – *The energy plan:* Proposals for profitable improvements for all types of energy and water consumption facilities in the building. Estimates of necessary investments and annual savings of improvements (including estimations of the technical lifetime of improvements). Information about the profitability of improvements under a given financing. – *Documentation:* Information on the present state of the building and the heating system, the use of energy under present owner, expected use of the building and the assumptions on which the energy label and the energy plan is based. Detailed information is given for every part of the building, including heating system, ventilation, insulation etc.	– *The energy label:* Standardised rating of the energy use for heating of the building. The calculated consumption of energy is placed on a scale from A1 to G2 (from 2008 on a scale from A1, A2, B to G). Includes information on the expected total energy consumption for heating in a reference year and the related costs. Includes also an estimate of the "potential" energy label the house would achieve, if all the recommended, profitable improvements were carried out (see below). – *The energy plan:* Proposals for improvements of heating and water consumption (water only until 2008); the proposals are divided into profitable improvements and "other improvements" respectively. Estimates of necessary investments, annual savings from improvements (in DKK and energy units) and the payback period of investments. – *Documentation:* A description of the characteristics of every part of the building (includes information on the energy efficiency of, for instance, loft insulation, windows, walls etc.). Each of the proposals for profitable improvements is described in further detail. Description of the assumptions on which the energy label and the energy plan is based.

Table 1: The content of the Danish Energy label report according to scheme 1997-2005 (*left*) and the scheme in force since January 2006 (*right*).

In 2008, an evaluation of all official Danish programmes and activities aimed at promoting energy savings was carried out (Togeby et al. 2008). With regard to the energy labelling scheme, the main conclusion of the evaluation was:

– The scheme still have a limited coverage
– Despite of improvement in quality compared with previous schemes, many labels are still marked by errors in the calculation
– The societal cost of the labelling process (including house owners' payment) is very high compared to the rather low effect which can be documented in actual saved energy units.

The evaluation estimated the coverage of the energy labelling scheme to be about 49% of all single-family houses sold in 2007. This estimate was subsequently criticized for being an under-estimation of the actual figure. In relation to an EU project called IDEAL-EPBD, the authors of this memo have made their own estimates, which indicate that at least about 60% of the new-built houses and houses put up for sale during 2007-08 had an energy la-

bel.[8] Thus, the coverage might be somewhat higher than showed by Togeby et al. 2008, but still far from complete.

The evaluation also showed that 43% of the energy labels issued in 2007 include recommendations for improvements that would result in an estimated increase in the energy label of the house of at least one category, e.g. from E to D, if carried out. One step up in energy class corresponds to a reduction in the energy consumption for heating of about 10%. (Togeby et al. 2008)

It appears from the evaluations mentioned above that the Danish Energy labelling scheme have had a little impact on the energy use for heating in Danish dwellings and the prioritizations of the homeowners. Besides the problems pointed out by the evaluations, a more fundamental explanation for this lack of success might be that the Danish Energy labelling system is based on a questionable assumption about the house owner as a "rational and enlightened actor". This assumption ignores that people relate to, interpret and question new knowledge rather than just take it in. Therefore, many aspects influence the "efficiency" of the energy label. For instance, trust in the reliability of the energy label (or in the energy consultant, who prepares the label) plays an important role for homeowners' reception of the energy label (there was in Denmark a general distrust in the energy labelling scheme in the first years). Also, personal contact between the house owner and the energy consultant seems to play an important role (there is no personal contact between the energy consultant and the new house owner in the Danish scheme). (Gram-Hanssen et al. 2007)

Another reason for the limited effect of the energy labelling scheme might be related to the kind of interests that motivate house owners to carry out energy improvements. The energy label report predominantly focuses on the financial and, to a lesser degree, the environmental benefits of doing energy improvements. However, research indicates that financial and environmental reasons are just two of many possible reasons (e.g. related to aesthetics, comfort, convenience or private finance). As part of the IDEAL-EPBD project, the authors have done a number of interviews, and these indicate that energy improvements in most cases have been made for *other* reasons than saving energy. Thus, many of the interviewees regarded potential energy savings as an *additional bonus* in relation to, for instance, replacing the windows for aesthetic reasons or because of a need for maintenance.

Energy taxes

There have been energy taxes in Denmark since 1977, and today they represent a considerable amount of what the households pay for their energy. An example calculated on the basis of electricity consumption in 2008 from the energy utility Dong Energy[9] show that a household pay 1,95 DKK (0,26 Euro) per kWh. This amount includes roughly 20% in VAT, 35% in energy taxes, 20% for distribution of electricity etc. and 25% for the basis electricity prize. The energy tax paid by households in Denmark is about 7 times higher than what the commercial sector pay in energy tax per kWh. Comparing these prizes and taxis with other European countries show that Denmark are among those with the highest energy taxes in pct of GDP, and this is especially true regarding the households (Økonomi og erhvervsministeriet, 2008)

[8] This estimate is based on statistics for the number of single-family houses (including terraced houses, semi-detached houses and farm houses) put up for sale during 2007-2008, the number of new-built single-family houses finished during 2007-2008 and the number of EPCs issued during 2007-2008

[9] Prizes found at www.Dongenergy.dk

The Danish authorities estimate that energy taxes over the last 30 years have resulted in 10% lower energy consumption compared to what it would have been without the energy tax, and they estimate that the households are more sensitive to energy taxes than the commercial sector, so the reduction in households are 16% (Økonomi og erhvervsministeriet, 2008). These estimates are based on the so-called EMMA model, which is part of a national macroeconomic model. This model calculates with a prize elasticity of 0,31, meaning that if energy prizes raise by 1% energy consumption fall by 0,31%.

Utilities' saving obligations

Utilities have been giving energy advises to their customers since the beginning of the 1990s, and the legal obligation for the utilities to promote energy savings have been part of the law since 1996. It is also part of the latest energy agreement from 2009, which includes specific reduction targets which the utilities are responsible for that their costumers carry out. In total, the utilities have to realise 6,1 PJ saved energy, with the Electricity utilities responsible for 2,9 PJ, District Heating companies for 1,9 PJ, Natural Gas companies for 1,1 PJ, and oil companies for 0,2 PJ. The utilities are free to choose their methods and it typically includes different types of advise, communication and economic incentives. However, the energy authorities require documentation from the utilities that they actually reach these targets on energy savings. This type of policy, where the authorities direct the responsibility to implement actions to private companies, can be seen as a changed policy paradigm towards more market based instruments, including public-private partnerships: the government set the targets of the energy policy, however, it is the private companies who are responsible to reach the goals, and it is assumed that they as a private market based company will do this in the most cost-effective way.

The target group of the utilities activities can be both the commercial sector and the households. In a recent evaluation of the Danish energy saving activities it is concluded that the main activities from the electricity companies have been directed towards industry, whereas the main target group of the district heating companies have been the households (Togeby et all, 2008). For 2006 and 2007, it is concluded that the companies reach 97% of their goals. In all cases, the activities towards renovation of the existing housing have been scarce, and the main focus have been on change of type of heat supply, towards more efficient technologies and towards gas and district heating rather than electrical heating. When recognizing the large potential for energy savings in the existing housing stock this must be considered a problem. A possible explanation for this relates to the way the energy companies have to document their savings towards the energy authorities. There are detailed rules as to how the energy companies should count the energy savings, including standard values for different initiatives, however, only the energy savings from the first year can be counted. As energy renovations of buildings normally have a longer payback time, this is not a very attractive area for the energy companies to pursue.

As an example on how the utilities work to implement their saving obligations, the following will report from offers found on the home page of one of the gas utilities, who uses financial incentives, advices and information as their means towards homeowners[10]. For instance, this gas utility offer grants for homeowners who will convert from electric heating to natural gas (9,500 DKK = 1266 Euro)), from oil to natural gas (3,800 DKK = 506 Euro) and from

[10] http://hmn.naturgas.dk/Kunde/~/link.aspx?_id=005CD098420149B0A630299E0F162458&_z=z

less efficient gas burners to more efficient (2-4,000 DKK = 266-533 Euro). Furthermore, the gas utility also, together with energy advising, offers grants for energy renovation of windows, walls and roof or for installing solar panel or heat pumps (0.42 DKK (0.056 Euro) for every saved kWh). The condition for obtaining this kind of grant is that the house owners sign an agreement with the utility, which will enable the utility to document that they can count the savings as part of their energy reduction commitment. The home page also gives advice on how to save energy for heating by different types of insulation and there is a possibility for asking questions to get energy advice.

It is, however, difficult for the utilities to document the effect of particularly information and energy advices. Therefore, they do not always get credit for this work on their saving obligations. A research project has worked on establishing standard values on some standard energy advice products from the electricity utilities, including giving education to schoolchildren on energy savings and handing out energy saving devices (Lynge Jensen, 2009). The project documented a measurable effect in saved kWh in the participating households from handing out saving devices; however, it was not possible to document a measurable effect from information to schoolchildren. This research raises the question if it is only relevant to carry out the type of information activities and campaigns that it is possible to estimate the exact effect of. General awareness and knowledge on energy, climate and environment might be just as important an element in energy policy, even though, it is not possible for the utility companies to document the effect in exact saved kWh of this kind of activities.

In general, what characterize this instrument is that the government has delegated the responsibility for realising energy savings to the private utilities. The utilities use both economic incentives and information as their means, and they focus on households as well as the commercial sector. According to the documentations from the utilities, they do realise their obligations. However, the way the utilities have to document their energy savings influence which type of energy savings they realise. In relation to households, substitution of inefficient heat technology is more widespread than energy renovation of the buildings, and general information and awareness rising in general do not really count.

Electricity saving trust

The Electricity Saving Trust was established in 1996 with the goal of promoting electricity savings in Danish households and the public sector. The Trust is an independent institution attached to the Danish Ministry of Climate and Energy and it is financed by a kind of tax on all electricity consumed by households and the public sector with 0.006 DKK/kWh, resulting in an annual budget of 90 million DKK (12 million Euro). The goal of the Trust was to promote 450 GWh electricity savings by the period 2007-09, whereof the household sector should represent 300 GWh. The Trust had from the beginning rather free hands to choose means and they have typically worked on both supply and demand side of energy efficient technologies. From the beginning a strong focus was on promoting electricity heated households to change to more energy efficient heating systems, and grants for households were part of this initiative. In recent years, focus have changed towards appliances, lighting and ventilation, and the activities directed towards consumers have changed towards campaigns in different types of media, web-based tools and voluntary agreements with producers and agents of energy efficient technologies, including energy labelling.

The activities of the Trust have been evaluated several times, and the general impression from these evaluations is that the Trust to a high degree meets its goals (Rambøll, 2004: Genius, 2008). It is however difficult to evaluate the different types of mass-communication, which the Trust have used towards the households, and count the effect in actual saved amount of kilowatt hours, and another evaluation questions some of these evaluations' results and methods (Togeby et all, 2008). When the Trust for instance have had a campaign for buying A-labelled refrigerators or circulator pumps, the effect should be evaluated as the difference between what was actually sold and what would have been sold without the campaign. The latter is however difficult to estimate, and there might furthermore have been other initiatives than that of the Trust to promote the sale. Also, the Trust has made a campaign on the importance of saving electricity in general and on knowing about one's own consumption. Evaluating on this type of campaign is primarily done by asking a representative part of the population if they know about the campaign and what they think of it, and whether the campaign has made them change habits. It is, however, not possible in a valid way to calculate a saved amount of energy based on this type of information. Again, it is not possible to say if it is only the specific campaign, which has made an impact. In spite of this, there is no doubt that the Electricity Saving Trust has had a positive impact on electricity efficiency and savings in Danish Households. According to their own estimate, Danish households would have had 10% higher electricity consumption today if it had not been for the Trust. By March 2010, the Trust will be closed and replaced by a new Centre for Energy Savings, which means that heat consumption and energy renovation of buildings will be part of the future work of the centre.

Other informative initiatives

As described in the previous, informative initiatives have been part of both the Electricity Saving Trust and the Utilities saving obligations, and obviously the energy label on buildings is also an example of an informative mean. However, there are also a few other initiatives in Denmark using information as a mean in promoting energy savings.

From 2005 to 2008, 25 million DKK (3.3 million Euro) per year was spend through an energy saving pool, primarily available for different types of NGOs and grassroot organisations working with energy and environment. Part of this money has been used for projects focusing on communication towards house owners on energy renovation: For instance, a project of 770,000 DKK (103,000 Euro) aiming at information on buildings and renovations including information in newspapers, a transportable exhibition to be placed in DIY centres and leaflets to be handed out. Other projects have focused on communicating energy savings to ethnic minorities, school children or owners of small shops. The energy saving pool was evaluated in 2008 (Catinét Research, 2008). The evaluation concludes that the money in general has been used according to the goals of the pool, and the projects have been carried out according to the projects descriptions. The administration has been smooth, without too much bureaucracy, which is important when a pool is giving money to a rather large group of small projects. There has been a debate about how the projects should document their effect, following that the utilities have to document very exact how many saved kWh their activities result in. The projects in this pool have not had these strict criteria for reporting results, but have used self-chosen criteria such as how many participated in an event or visited an exhibition. The evaluation raises the debate on which criteria to use for evaluation: on one hand, it is not possible to document the value for money of these projects compared to other energy

saving initiatives, if they cannot document actual saved kWh. On the other hand, it would not be possible to carry out most of these projects, if it was a prerequisite to document the energy exact savings.

In the latest energy agreement from February 2008, there are also appropriated 20 million DKK (2.66 million Euro) per year to campaigns promoting energy savings in buildings. The first round of campaign funding has been distributed in April 2009 to various projects including (Energistyrelsen, 2009):

– A local bank giving in-service course to their financial housing advisers on helping house owners to engage in energy renovations.
– A local NGO making projects on the advantages of energy labels on buildings and how house owners can use and benefit from them.
– A consortia of private and public companies training craftsmen in advising house owners on energy renovation.
– The lobbying organisation for Danish business making competitions among private homeowners on the issue of energy renovations.

There is not yet any documentation or evaluation on these types of initiatives. Half of these 20 million DKK per year are in the years 2008-2011 devoted to a Knowledge Centre for energy savings in buildings, run by a consortium of private and public partners (including the Danish Building Research Institute). The purpose of the knowledge centre is to collect knowledge on how to reduce energy consumption in buildings and communicate it to the professional actors in the building sector. The centre will be evaluated in 2011.

Another type of communicative initiative is feedback to households on their energy consumption. In the agreement between the authorities and the utilities it is established that the utilities have to make informative bills to the consumer, typically including information on the households own consumption now and previously and possibilities of comparing this consumption with other similar households. Another example of feedback is from Albertslund Municipality, where they for more than a decade every year have published green accounts with average electricity, heat and water consumption for the different neighbourhoods in the municipality, allowing neighbourhoods to compete with each other on lowering consumption, and also making yearly green accounts where the individual households can compare themselves with others (anonymous) in their neighbourhood. There is no evaluation on the energy savings gained from the Danish informative billing or the municipality project, however, an international review concludes that 10% savings from this type of activities might be realistic (Fischer, 2008; Willhite and Ling, 1995). A recent Danish research project with a high statistically valid population, however, only documented 3% reduction in electricity based on sms-text messages with feedback on consumed electricity (Glerup et all, forthcoming).

The final type of informative projects to describe here are demonstration projects on energy renovations. One recent example is provided by Realea, part of the private Fond Realdania, who has engaged in a demonstration project with energy renovation of three different, but typical, Danish detached houses. The idea is afterwards to describe and communicate the experiences to the public. There are not yet any documented results of this project[11].

[11] For information in Danish see: http://www.realea.dk/Ejendomme/V-ae-lg%20ejendom/Project.aspx?id={D36F64A5-E59E-48D6-9CC9-7A850BA27554}

Other initiatives involving economic incentives

As described above, economic incentives to households have to a smaller degree been part of both the Electricity Saving Trust's work and the energy utilities' saving obligations in the form of grants to households, typically for changing to a more energy efficient heat supply. The Danish energy taxes are of course also a type of economic incentive. Apart from these there are few examples of economic incentives towards Danish households in the form of grants; however, this is not the most used mean to promote energy savings in Denmark.

Examples of grants given to households include for instance grants for energy saving measures for pensioners' dwellings in 1993 to 2003, and grants for the connection of houses built before 1950 to district CHP systems in 1993 to 2002 (MURE-database, 2010). Further more in march 2009 the Government decided to establish a "Growth Fond" with 1,5 billion DKK (200 million euro) to get going the Danish construction sector. The fond provided subsidy for renovations and building projects in private housing including energy renovations. A survey among the more than 100.000 households who had a grant from the fond has been carried through[12]. This survey concludes that for more than 90% of the households the grant accelerated the project (typically 1 – 2 years), whereas less than 10% of the households' states that without the grant the project would never have been carried through. More than 60% of the households states that energy saving was part of the reason for starting the project, and more than 80% states that the projects will result in lower energy consumption. Another recent example of grants are the so-called "scrap arrangement" for oil-fired burners (Energistyrelsen, 2010). Households having oil-fired burners which they want to substitute with heat pumps, solar heating and district heating can apply for a grant of between 10,000 and 20,000 DKK (1.333-2.666 Euro). This initiative is not yet evaluated.

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http://www.oem.dk/graphics/oem/nyheder/Pressemeddelelser%202009/Renoveringspulje%20Afrapportering%20af%20interview%20fra%20Capacent.pdf

Conclusions and lessons learned

This memo introduces and examines Danish policy initiatives aimed at energy savings in single-family homes. One way of concluding on this material is by comparing the different initiatives with each other looking at the overall societal expenses compared to the saved energy. A recent evaluation of all Danish energy saving initiatives did this (Togeby 2008). It concluded that the Electricity Saving Trust, the utilities' saving obligations and the building regulations all are cost-effective, whereas the energy labelling scheme are too expensive compared with its rather limited documented effect.

There are, however, problems related to this type of calculations. One is related to the calculation of the cost-effectiveness of energy saving initiatives as it is not possible to estimate the effect in saved kilowatt hours for some types of initiatives. This is true for most of the communicative initiatives, which have a general awareness raising approach. It is, however, not true, that awareness is not important for the actual level of energy consumption in the long run.

A possible conclusion on the lessons learned from the Danish initiatives towards energy renovation of detached houses could be to continue having an approach where authorities use market actors as the utilities, however, include other ways of calculating the effect, making it attractive for the utilities to work also with energy renovation of existing buildings. Furthermore, take into account how projects with a high degree of information and awareness raising can be documented in other ways than through saved kilowatt hours. When considering this, it is important to maintain the idea, that when giving public money to private companies, NGOs and others, there must be rather strict criteria for the evaluation of whether the money are actually used in an adequate way, and there must also be a limited bureaucracy to keep the cost for this down and to make it attractive for relevant partners to engage in the project.

In relation to the energy labelling scheme there can be pointed at different ways of improving the scheme. The labelling is mandatory according to EU regulation, and there have been strong investments in building up the scheme, and there is no doubt that it should continue. Improvements could include experiments with that the buyer rather than the seller should order the label, allowing for a personal contact between house owner and energy auditor. Experiments with that primarily older houses, or houses with the highest annual energy costs, and thus with the highest potential for energy savings should be labelled, combined with sanctioning by authorities in case of missing label. Furthermore, the labelling process could be combined with financial means and means including building companies and craftsmen, making it as easy and convenient for the house owner to carry out the recommended renovations.

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This report contains a memo written as an input to the German project Enef-haus on energy-efficient restoration of single-family houses in Germany. The memo contains a summary of the Danish experiences divided into three main sections: first is a short historic overview of the Danish energy policy indicating when different relevant instruments have been introduced to increase the energy efficiency of privately owned single-family houses. Second is a short introduction to the Danish housing sector and its energy supplies. The third and main part of the report is an examination of the most recent and relevant instruments concluding both on the results concerning the impact of the instruments especially on owners of single-family houses and on more general experiences with their implementation. Finally the memo concludes on the general lessons that can be learned from the Danish experiences.

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